

Patent Claims

1. A process for producing an inorganic-inorganic composite material, in which
  - 5 - after shape-imparting processing and presintering of a powder containing oxide ceramic, an open-pore, crystalline oxide ceramic shaped part is produced,
  - 10 - an infiltration substance is applied to this shaped part, preferably in vacuo and at room temperature, and
  - 15 - under air atmosphere and at ambient pressure, the oxide ceramic is sintered in a densifying manner to form the inorganic-inorganic composite material.
2. The process as claimed in claim 1, characterized in that the presintering takes place at a temperature of from 600 to 1300°C.
- 20 3. The process as claimed in one of the preceding claims, characterized in that evacuation is carried out to less than 40 mbar, preferably 10 to 30 mbar.
- 25 4. The process as claimed in one of the preceding claims, characterized in that for the shape-imparting processing the powder containing oxide ceramic is provided with an organic binder and pressed.
- 30 5. The process as claimed in claim 1 to 3, characterized in that the organic binder is an ethylenic wax material, in particular an ethylenic wax, a polyvinyl resin, a polyvinyl pyrrolidone, 35 polyvinyl acetate, a polyvinyl butyl and/or cellulose.

- 5 6. The process as claimed in one of the preceding claims, characterized in that the infiltration substance is applied in a layer thickness of from 2 to 90% of the thickness of the open-pore crystalline oxide ceramic.
- 10 7. The process as claimed in one of the preceding claims, characterized in that the layer thickness of the infiltration substance is from 2 to 30%, preferably 5 - 20% of the thickness of the dense-sintered inorganic-inorganic composite material.
- 15 8. The process as claimed in one of the preceding claims, characterized in that the infiltration substance, for the coloring and de-sintering, is applied in a layer thickness of 5 - 90%, preferably 10 - 90% of the thickness of the presintered oxide ceramic shaped part.
- 20 9. The process as claimed in one of the preceding claims, characterized in that the infiltration substance consists of a precursor of a non-metallic-inorganic phase, or an amorphous glass phase and a solvent, or of a hydrolysable compound of a metal, or contains an alkoxide of a metal, or a precursor of a silicate glass, in particular a hydrolysable silane.
- 25 10. The process as claimed in one of the preceding claims, characterized in that the infiltration substance is applied in the presence of a solvent.
- 30 11. The process as claimed in claim 10, characterized in that a polar or nonpolar solvent is used.
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12. The process as claimed in claim 10 or 11, characterized in that the solvent used is water or alcohol.
- 5 13. The process as claimed in one of the preceding claims, characterized in that further external shaping of the composite material by material-removing machining and/or etching takes place prior to the infiltration.
- 10 14. The process as claimed in one of the preceding claims, characterized in that after the infiltration the composite material is fully sintered, at a temperature of 1000°C to 1600°C, to
- 15 a theoretical density of at least 99.5%.
15. The process as claimed in one of the preceding claims, characterized in that the external shaping of the composite material by material-removing
- 20 machining and/or etching takes place after the infiltration or after the full sintering, which takes place in particular at ambient pressure.
16. The process as claimed in one of the preceding
- 25 claims, characterized in that an at least one-layer coating of a veneer material is applied at least to sections of the surface of the composite material and is subjected to a further heat treatment in particular after it has been
- 30 applied.
17. The process as claimed in one of the preceding claims, characterized in that an adhesive is applied to at least sections of the surface of the
- 35 composite material, and a further material is attached.

18. The process as claimed in one of the preceding claims, characterized in that a material-removing machining operation for shaping purposes, in particular with an oversize of from 10 to 50% and preferably with an oversize of from 15 to 30%, is carried out following the partial sintering of the composite material.
19. The process as claimed in one of the preceding claims, characterized in that the powder containing oxide ceramic is processed to form an open-pore oxide ceramic shaped part in the form of a monolithic block or cylinder.
20. The process as claimed in claim 19, characterized in that the monolithic block or cylinder undergoes chip-forming machining.
21. The process as claimed in claim 20, characterized in that after the chip-forming machining the infiltration substance is applied in vacuo.
22. An inorganic-inorganic composite material, characterized in that it has a translucent inner region made from a crystalline oxide ceramic and a layer of an infiltration substance which at least partially surrounds or covers the inner region.
23. The composite material as claimed in claim 22, characterized in that it is obtainable by dense-sintering from an open-pore, crystalline oxide ceramic which contains oxides or oxide mixtures of the elements zirconium, aluminum, or titanium or mixtures of said oxides or oxide mixtures with oxides of the elements from groups IIIa, IIIb, IVb of the periodic system of the elements, preferably with oxides of the metals Hf, Y, Al, Ce, Sc, Er or Ti, or with mixtures of these

oxides, where a denotes the main group elements and b denotes the transition group elements of the periodic system.

- 5    24. The composite material as claimed in one of the preceding claims, characterized in that the open-pore, crystalline oxide ceramic contains zirconium oxide and additions of yttrium oxide.
- 10   25. The composite material as claimed in one of the preceding claims, characterized in that the zirconium oxide contains additions of from 2 to 4 mol%, in particular in the range from 2 to 10 mol% of yttrium oxide or of 2.5 to 15 mol% of cerium  
15   oxide or 2.5 to 5 mol% of erbium oxide or 2.5 to 5 mol% of scandium oxide or of 0.1 to 15 mol% of titanium dioxide or mixtures of two or more of the abovementioned oxides in the quantities indicated.
- 20   26. The composite material as claimed in claim 22, characterized in that the zirconium oxide contains additions of from 2 to 4 mol% of yttrium oxide.
- 25   27. The composite material as claimed in one of the preceding claims, characterized in that the open-pore, crystalline oxide ceramic contains aluminum oxide and mixtures of further metal oxides and/or zirconium oxide, preferably tetragonal zirconium oxide.
- 30   28. The composite material as claimed in one of the preceding claims, characterized in that the infiltration material contains as precursor a non-metallic-inorganic phase or an amorphous glass  
35   phase or a hydrolysable compound of a metal or of an alkoxide of a metal selected from the group consisting of the elements Al, Ti, Zr or Si or a hydrolysable silane.

29. The composite material as claimed in claim 28, characterized in that the primary phase of the non-metallic-inorganic phase contains ionogenic or covalent compounds of the elements of groups Ia, IIa, IIIa, IVa, IIIb, IVb, Vb, VIb, VIIb, VIIIb, where a denotes the main groups and b the transition groups of the periodic system of the elements.
30. The composite material as claimed in claim 28, characterized in that the infiltration substance contains covalent bonds of Si and/or Zr.
31. The composite material as claimed in claim 28, characterized in that the infiltration substance contains ionogenic compounds which have a coloring action, preferably Ce, Mn, V, Fe or mixtures of said elements.
32. The composite material as claimed in claim 28, characterized in that the amorphous glass phase is silicate glass, preferably an alkali-metal-free silicate glass.
33. The composite material as claimed in claim 28, characterized in that the infiltration substance contains tetraethyl orthosilicate as hydrolysable compound.
34. The composite material as claimed in claim 28, characterized in that the infiltration substance contains alkoxides of silicon or aluminum.
35. The composite material as claimed in one of the preceding claims, characterized in that the inner region is translucent and the layer of infiltration substance is cloudy-white.

36. The composite material as claimed in one of the preceding claims, characterized in that the inner region has a theoretical density of >99.5% and a  
5       biaxial strength of no less than 800 MPa and a fracture toughness of more than  $6.5 \text{ MPa m}^{1/2}$ , measured using the indenter method.
37. The composite material as claimed in one of the preceding claims, characterized in that the inner  
10       region has a translucency which corresponds to that of hot isostatically pressed sintered ceramics.
38. The use of the crystalline, open-pore oxide ceramic and of the inorganic-inorganic composite material produced therefrom as claimed in one of  
15       claims 20 to 36 in the dental sector, preferably as a dental restoration, implant, implant part or orthodontic product.  
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39. The use as claimed in claim 38, characterized in that the dental restoration is a dental framework, a crown, a partial crown, a bridge, a cap, a  
25       shell, a veneer, an abutment or a post structure.